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(54) Subject of Invention Manufacturing Method of Metal-Coated Optical Fiber

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DETAILED DESCRIPTION

1. Subject Of Invention

Manufacturing method of metal-coated optical fiber

2. Scope of the Patent Claim

(1) A manufacturing method of metal-coated optical fiber having the following characteristics: after forming a metal coating layer whose boiling point is more than the fiber spinning (drawing) temperature onto the outer circumference of a preform rod, the preform rod is spun (drawn) into fiber.

(2) In the manufacturing method of metal-coated optical fiber described in Claim Item (1), Scope of the Patent Claim, the metal coating layer is preheated to the vicinity of the melting temperature of the metal coating layer.

(3) In the manufacturing method of metal-coated optical fiber described in Claim Item (2), Scope of the Patent Claim, the preheating is performed in an oxygen atmosphere.

3. Detailed Explanation of the Invention

The present invention is related to a manufacturing method of metal-coated optical fiber.

The forming of metal protective layer as a coating of optical fiber has already been proposed. In the case of a metal coating layer, it has been regarded to be better in mechanical strength compared to a plastic coating layer, as well as higher in heat resistance refractory property and water resistance humidity prevention property, etc.

Hitherto, in the manufacturing of the aforementioned metal coated optical fiber, after the optical fibber is manufactured by a spinning (drawing) process (heat elongation process), a metal coating layer is formed onto the outer circumference of the optical fiber by an established method. However, in this approach, non-uniform adhesion and other (defects) tend to occur at the interface between the optical fiber composed of quartz, etc. and the metal coating layer. By this, the transmission performance after the metal coating would be lowered.

In this regard, in the case where the optical fiber is coated with metal such as aluminum or titanium (coating thickness 10 to 20 um), there are references that more than 1 dB/km loss increases have occurred. Therefore, an improvement is being demanded.

The present invention is undertaken in view of the aforementioned problematic points to improve the __ (1character illegible) manufacturing method of metal coated optical fiber. A concrete method is illustrated below. As shown in Fig 1, to the outer circumference of the preform rod 1 composed of quartz system, the metal coating layer 2 is formed.

For the aforementioned metal coating layer 2, the metal materials (to be described later) possessing boiling points which are higher than the fiber spinning (drawing) temperature are employed. Concrete examples include aluminum (2270°C), chromium (2200°C), titanium (above 3000°C), Nickel (above 3000°C), etc. [The number in the parentis shows the boiling point.]

In this case, the metal coating layer 2 can be formed onto the outer circumference of the preform rod through the established metal vapor deposition method, the chemical plating method, etc. In the forming of the coating layer 2, the tight adhesion with the glass is important. Namely, the preform rod 1 is spun (drawn) into fiber as shown in Fig 2 by the heating in the spinning (drawing) furnace 3 and by an elongation (pulling) means (not shown in the figure) to become the metal coated fiber 4 of the desired fiber diameter.

Here, the spinning (drawing) temperature is set to be within the range of generally 1800 to 2200°C; this temperature is lower than the boiling points of the aforementioned metals.

And, in this spinning (drawing) process, the aforementioned metal coating layer 2 can be either preheated or without a preheating. In the case when it is preheated, the metal coating layer 2 is heated to the vicinity of the melting point of the metal through the heater 5 arranged at the front step of the spinning (drawing) furnace 1 (should be "3": a misprint). Further, through the oxygen supply system 6, the inside of the heater 5 is maintained in oxygen atmosphere.

By the aforementioned preheating, if the metal coating layer 2 is heated to high temperature condition, the tight adhesion between the metal coating layer 2 and the preform rod 1 would be improved; and in the case where this heating is carried out in the oxygen atmosphere as described above, an oxide coating film of high melting point would be formed on the surface of the metal coating layer 2. As a result, the surface condition of the metal coating layer 2 after the

spinning (fiber drawing) would become better. The effect similar to that achieved by two kinds of metal coating can be obtained.

In this, the spinning (fiber drawing) temperature is preferably set to be higher than the melting point of the metal and lower than the level of the melting point of the metal oxide.

Moreover, for the spinning (fiber drawing) furnace 3, if a zirconia furnace is employed, the preheating can be performed simultaneously in an oxygen atmosphere in this furnace 3.

In the case when the metal coated optical fiber 5 is manufactured as described above, the followings advantages would be obtained.

Namely, in the above description, the metal is not coated at the optical fiber step; instead the metal is coated at the step (stage) of preform rod 1; and it is then spun (drawn into fiber).

Therefore, during the spinning (fiber drawing) after the metal coating layer 2 has been coated-onto the preform rod 1, since the metal coating layer and the rod 1 are to be heated-melted together, the tight adhesion condition at the interface of the two would become uniform and strong. As a result, the so called increase in transmission loss by the metal coating would not occur; thus the desired transmission performance can be maintained.

Of course, since the aforementioned metal coating layer 2 possesses a boiling temperature which is higher than the spinning (fiber drawing) temperature, during the spinning, the metal would not be vaporized; thus it can be guaranteed that the problems associated to the mechanical strength, heat

resistance refractory property, water resistance humidity prevention property would not occur.

And, when the metal coating is performed at the step of preform 1 with large diameter, the breakage loss in the handling would be almost eliminated compared to the case where the metal coating is performed onto the extremely fine optical fiber. And also the temperature (best guess; poorly copied) during the metal coating can be moderated. Furthermore, even if the thickness deviation in the metal coating has occurred somewhat, due to the large diameter of the preform rod 1, the thickness deviation percentage would not become a large value; therefore, homogenization of the metal coating can be easier to achieve from these view points.

Implementation Example

The preform rod 1 of outside diameter 15 mm composed of core portion by SiO_2-GeO_2-P_2O_5 system and clad portion by SiO_2 was prepared. To the outer circumference of this rod, the metal coating layer 2 composed of Cr was formed by vacuum vapor deposition; then, the metal coating layer 2 was heat-treated once in air by an oxyhydrogen flame burner.

Next, the metal coated preform rod 1 coated with the metal as described above was spun (fiber drawn) in a carbon resistance furnace (the spinning furnace 4) of about 1980°C to obtain the GI type metal coated optical fiber 4 which is 50 μm in core diameter, 125 μm in fiber diameter, 1 mμm in the metal coating layer 2 thickness after the spinning, 1% in specific refractive index difference.

The transmission performance of the metal coated optical fiber 5 obtained as described above was measured by wavelength 0.85 um: the transmission loss was 2.35 dB/km.

For comparison, an identical preform rod of the above described was spun (fiber drawn) without the metal coating to prepare an optical fiber of core diameter 50 um, fiber diameter 125 um. The transmission loss of this fiber was measured; the result was 2.32 dB/km.

When the two examples are compared, even though in the implementation example of the present invention, a metal coating is applied, the increase in the transmission loss compared to the fiber without the metal coating was limited to a very small value: the effectiveness of the present invention was verified.

And it was verified that even if the thickness of the metal coating layer 2 after the fiber drawing is below 1 mμm, there is no problem related to the water resistance humidity prevention property.

As described above, by the technical means possessing the characteristics of the present invention method, since a specified metal coating layer is formed at the step (stage) of preform rod, and this is then spun (drawn) into fiber, the original transmission performance would not be lowered and yet a metal coated optical fiber possessing homogeneous metal coating layer can be manufactured.

4. Brief Explanation of Figures

The figures show an implementation example of the present invention. Fig 1 is the cross section showing the metal coated state of a preform rod. Fig 2 is an illustrating diagram showing the spinning (fiber drawn) state of the rod.

1...preform rod

2...metal coating layer

3...spinning (fiber drawing) furnace

4...metal coated optical fiber

5...heater

6...oxygen supplying system

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Fig 1

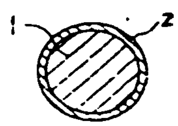

Fig 2